Assessing and reducing the risk of ground-water contamination from

Animal Manure Storage

Keeping Idaho's — Water Clean

Fact/Worksheet 7

Why should I be concerned?

Farmers store animal manure so they can spread manure when crops need the nutrients. They save money because they don't need to purchase as much fertilizer. Accumulating manure in a concentrated area, however, can be risky to the environment and to human and animal health. Poorly designed or mismanaged manure storage systems can allow contamination of surface or ground water sources by the nutrients and disease-causing organisms contained in animal wastes.

Facilities which store manure in liquid form on the homestead may leak or burst, releasing large volumes of pollutants. Manure in earthen pits under some soil conditions form a semi-impervious seal of organic matter that does limit leaching potential, but seasonal filling and emptying can cause the seal to break down. Short-term solid manure storage and abandoned storage areas can also be sources of nitrate contamination of ground water.

If nitrate concentrations in drinking water are greater than federal and state drinking water standards of 10 mg/L,* nitrate-nitrogen can pose health problems for infants younger than six months of age, including the condition known as methemoglobinemia (blue baby syndrome). Young animals are also susceptible to health problems from high nitrate-nitrogen concentrations. Concentrations of 20-40 mg/L in the water supply may prove harmful, especially in combination with high concentrations (1,000 ppm) of nitrate-nitrogen from feed sources.

Animal wastes are potential sources of approximately 150 diseases. Illnesses potentially transmited by animal manure include diseases such as typhoid fever, cholera, tuberculosis, and polio. Organic materials that lend an undesirable taste and odor to drinking water are not known to be dangerous to health, but their presence suggests that other contaminants can be flowing into ground water. The detection of any coliform bacteria in a drinking water sample is considered as "bacteriologically unsafe."

The goal of Home*A*Syst is to help you protect the environment and your drinking water.

*means milligrams per liter, equivalent to parts per million for water measure

How will these materials help me to protect my drinking water?

- It will take you step-by-step through your animal manure storage practices.
- It will rank your activities according to how they might affect the ground water that provides your drinking water supply.
- It will provide you with easy-to-understand rankings that will help you analyze the risk level of your animal manure storage practices.
- It will help you determine which of your practices are reasonably safe and effective, and which practices might require modification to better protect your drinking water.

How do I complete the worksheet?

After reviewing the information provided, follow the directions at the top of the chart on page 8. It should take you about 15 to 30 minutes to complete this worksheet and summarize your risk rankings.

Glossary

Animal Manure Storage

These terms may help you make more accurate assessments when completing Fact/Worksheet 7. They may also help clarify some of the terms used.

Composting facility: A facility for the biological decomposition and stabilization of manure organic material.

Concrete stave storage: A type of liquid-tight animal manure storage structure. Located on a concrete pad, it consists of concrete panels bound together with cables or bolts and sealed between panels.

Earthen basin or pond: Clay-lined manure storage facility constructed according to specific engineering standards. Not simply an excavation.

Engineering standards: Design and construction standards available at Natural Resources Conservation Service (NCRS) or Cooperative Extension System (CES) offices. These standards may come from NRCS technical guides, state regulations, or land grant university engineering handbooks.

Filter strip: A gently sloping grass plot used to filter runoff from the livestock lot and some types of solid manure storage systems. Influent waste is distributed uniformly across the high end of the strip and allowed to flow down the slope. Nutrients and suspended material remaining in the runoff water are filtered through the grass, absorbed by the soil, and ultimately taken up by plants. Filter strips must be designed and sized to match the characteristics of the animal lot or storage system.

Glass-lined steel storage: A type of liquid-tight, above-ground animal waste storage structure. Located on a concrete pad, it consists of steel panels bolted together and coated inside and outside with glass to provide corrosion protection.

Manure storage pond: An impoundment made by excavation or earthfill for temporary storage of animal or other agricultural waste.

Manure treatment lagoon: An impoundment made by excavation or earthfill for biological treatment of animal or other agricultural waste.

Nutrient management plan: A plan to manage the amount, form, placement, and timing of applications of plant nutrients.

Poured concrete storage (manure tank): A type of liquid-tight animal manure storage structure. Located on a concrete pad, it consists of poured concrete reinforced with steel, and may be above ground or below ground.

Water table depth: Depth to the upper surface of ground water. This depth is sometimes indicated in the county soil survey, but varies from county to county. This information may be available from your well construction report or from hydrogeological reports and ground-water flow maps of your area. Your county Cooperative Extension System agent, NRCS specialist, or a local well driller may also be able to help you gather this information.

> There are two types of water tables: (1) the water table typically noted in a well log as an indication of usable water supply; and (2) the seasonal high water table. The seasonal high water table is more important in regard to construction of animal manure storage facilities because it may present facility construction problems.

Keeping Idaho's Water Clean

Improving Animal Manure Storage

When animal manure is stored, it must be accumulated in some type of structure until it can be applied to the land. Manure storage can be either positive or negative from an environmental standpoint.

Manure storage can benefit the environment if it is stored until it can be safely spread, incorporated into the soil, and used by a growing crop. The environmental safety of collecting large amounts of manure in one place for an extended period is dependent on four factors:

1) Proper design, construction, and operation of the storage facility.
2) Proper land application of the manure once it leaves the storage facility.
3) Physical and chemical characteristics of the soil and subsurface geologic materials within the storage area, as well as the area to which any runoff might flow.
4) Potential for ground-water contamination.

Stored manure should be applied according to a schedule which is developed as part of an overall operating plan. Consider weather conditions, nutrient uptake requirement of crops, availability of help and equipment, field availability, and the accumulation of waste. The best times for land application are spring, just before planting, and fall (before snow and frozen soil conditions occur). Apply manure to fields containing the greatest amount of actively growing vegetation or crop residue, and incorporate to maximize utilization of nutrients. Winter application is not recommended. Storage facilities should be designed and maintained to eliminate the need for winter application.

Stored manure can easily be sampled and tested to determine how much nitrogen, phosphorus, and potassium it contains. When sampling manure, be sure to obtain as representative a sample as possible. This information, combined with a knowledge of the amount of manure applied per acre, determines whether additional commercial fertilizer is needed to meet realistic crop production goals.

Adequate manure storage reduces the need for land application during winter months when soil is saturated or frozen. This improves efficiency, saves wear and tear on equipment, conserves nutrients contained in the manure, prevents soil compaction, and minimizes manure nutrient leaching and runoff.

1. Long-term storage

Animal manure can be stored either in solid, semi-solid, or liquid states:

- Composting can be an alternative.
- Solid facilities stack heavily bedded manure against walls and on slabs.
- Semi-solid facilities use pumps to move manure into containment areas and may seperate solids from liquids.
- Liquid facilities hold manure in tanks or manure storage ponds.

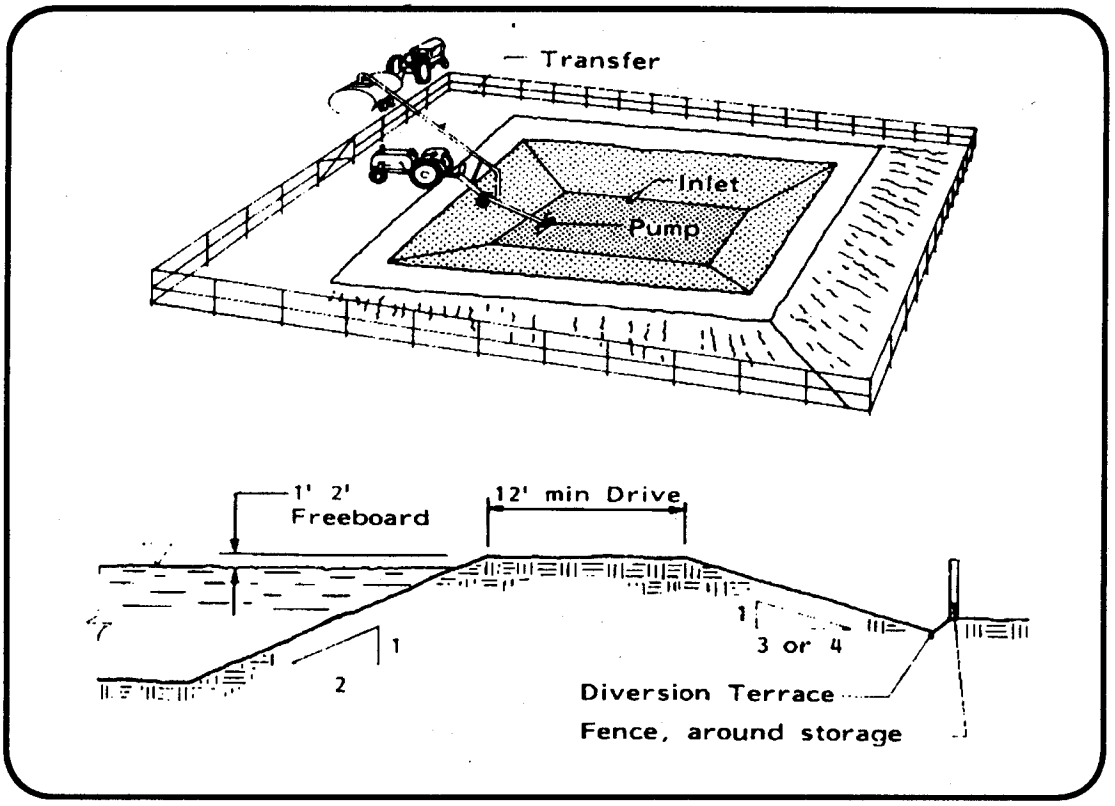

Figure 1: Earth basin for manure storage. *Source: Livestock Waste Facilities Handbook, MWPS-18, Midwest Plan Service, Ames, Iowa.*

Liquid and semisolid storage systems are self-contained (*Figure 1*). Ground-water contamination can occur if the facility is not structurally sound and properly lined, allowing contaminants to seep into the soil. A threat to surface water exists if manure storage structures are not emptied frequently enough, thereby allowing manure to flow over the top of the structure.

Liquid storage systems should have sufficient storage capacity to handle animal manure during the rainy season and extreme storm events. Storage for 180 days and a 25-year, 24-hour storm event is usually recommended for facilities in Idaho. Additional storage capacity is recommended for a one in five year storm event and normal precipitation containment.

Liquid storage systems require the use of pumps and pipes for moving wastes from the barn to the storage structure. These must be properly installed and maintained to ensure that they do not leak.

Each time they are emptied, carefully check **steel and concrete structures** for cracks or the loss of watertight seals. If any breaks are apparent, repair them immediately. Likewise, check the walls of **manure storage ponds** when emptied to be certain that liner materials are not cracked or eroded.

While seepage from in-ground manure storage facilities is not always easy to recognize, there are some telltale signs:

- A properly designed structure has the capacity to handle manure from a specific number of animals for a known number of days. If a pit designed for 180 days of storage receives designated manure amounts, but does not fill to the design level in six months, the pit may be leaking.

- Evaporation from liquid storage pits is minimal during the late fall, winter, and early spring. If additional liquids have to be added in the spring before a pond can be

agitated and pumped, it may be leaking. During warmer months, addition of liquids may frequently be needed for pumping due to evaporation losses. Monitoring wells installed around the pond upslope and downslope would be encouraged to confirm seepage.

Another method of determining leakage is through the construction and use of a stilling well. It is an eight or ten inch section of perforated PVC pipe secured in a vertical position to the bottom of the waste lagoon. The length should be about six inches taller than the depth of the lagoon when the water height is read. A hook gauge is used to very accurately measure the depth of the lagoon over a two week period. Evaporation losses are accounted for through use of an onsite evaporation pan. During the period of measurement, no liquid should enter nor leave the lagoon. Alternative holding structures are needed during the measurement period.

Some facilities for storage of solid or semisolid manure are designed to allow seepage from the stack. In these instances, structure design must include treatment for the wastes that seep out. Use of these facilities should only be for control and treatment of lot runoff wastes, not for continuous, concentrated wastes such as swine slurry or dairy wastes. If conditions allow, structures such as picket dams can be used to hold back solids, and grass filter strips can be used to help remove remaining pollutants in lot runoff water. These systems should not be considered on sites with coarse-textured soils, creviced bedrock, or shallow water tables. Care must be taken to ensure that the system is not overloaded.

Both systems require maintenance. With grass filter strips, it is important to ensure that the ammonia in highly concentrated manure does not "burn" vegetation in the filter strip. A thick, healthy stand of vegetation allows runoff to seep into the soil and uses the nutrients in the water.

The best way to handle seepage is to channel it into a watertight holding pond or storage tank. In those areas where not enough soil is available for the construction of filter strips, or where the construction of a holding pond is not feasible, another option is to build a roof over the structure to eliminate additional water being added to the manure stack. Roofed storage systems require adequate bedding to absorb and retain the liquid portion of the manure.

2. Short-term storage

Short-term storage allows producers to hold animal manure during periods of bad weather when spreading may not be feasible, when crops are growing and land is not available for applying manure, or when there is a shortage of crop acres to handle frequent hauling and spreading of manure without the threat of runoff.

Short-term storage has the disadvantage of requiring that the manure be handled twice. Designs are available, though, for **short-term storage structures** that facilitate handling and provide effective protection for surface and ground water.

Short-term storage systems may be applicable if you often find that you must **stack manure in fields,** particularly during periods of bad weather. This is not a recommended practice. No matter how it is done, it poses a contamination threat to surface and ground water. If manure is frequently stacked in fields, it might be appropriate to consider constructing a short-term storage facility.

Scraping manure into **piles in the animal lot** during bad weather or busy work periods is not recommended because of possible herd health problems and water pollution. The severity of those problems depends on characteristics of the animal lot area where the manure is piled and the area to which runoff flows.

Open housing, such as pole sheds, are often used to allow manure to accumulate for extended periods of time. Roofs on these structures keep rain and snow off the manure. These structures are relatively safe for water quality if they are protected from surface water runoff, and if adequate bedding is provided to absorb liquids in the manure. To minimize water quality impacts, **provide adequate bedding to reduce seepage and clean these sheds as frequently as possible.**

The use of long-term storage methods is preferable to short-term techniques. Long-term storage practices and structures are generally better designed to deal with unplanned occurrences, such as major storm events, and provide better overall protection of water quality.

3. Manure storage location

Urban development, zoning ordinances, proximity of residences, business, recreational areas, roads, and highways need to be considered. Recommended minimum distances from a waste storage facility are:

Domestic well: 100 feet; 200-300 feet preferable.
Public well: 1,000 feet (from Wellhead Protection Program).
Property line: 300 feet.

Expected growth of residential areas should always be considered in site selections. In some cases, zoning requirements may be more restrictive than these recommendations. Contact your local county office of planning and zoning for specific information. See listing under County Government in the phone book.

Minimum separation distances should guide new well installation or the distance from existing wells to new manure storage facility construction. Make every effort, however, to exceed the regulations and strive to meet current recommendations whenever possible.

Observing these separation distances when siting a new facility is a good way to help protect your drinking water. Locate manure storage facilities downslope from the well to protect your water supply. For more information about separation distances and how the condition of your well might affect the potential for contamination (See Fact/Worksheet 1, *Drinking Water Well Condition*).

While observing well separation minimum distances may help to protect your own well, poorly designed or poorly maintained animal manure storage facilities could still contaminate the ground water that supplies other local drinking water wells. Protecting the ground water resource as a whole can help protect your neighbors' wells, as well as the quality of drinking water supplies for future generations.

Depth to seasonal high water table or fractured bedrock and soil type at the manure storage location are other important factors. These are among the site vulnerability characteristics covered in *Worksheet A, Site Evaluation.*

It is important that earthen waste storage structures not leak or otherwise excessively discharge pollutants to surface or ground waters (potentially causing a violation of Idaho State Ground Water Quality Standards). The Idaho Department of Health and Welfare-Division of Environmental Quality (IDHW-DEQ) administers these standards and encourages the use of Natural Resources Conservation Service (NRCS) standards and specifications for the location, design, construction, and operation of these structures. The Idaho Waste Management Guidelines for Confined Animal Feeding Operations can also provide valuable information.

Depth to water table is sometimes available in the county soil survey, but this varies from county to county. Your county Cooperative Extension System agent, NRCS, Soil Conservation District personnel, or a local well driller may also be able to help you gather this information.

4. Land application of animal manure

Land application is the predominant method of using animal manure. When properly managed, land application offers safe and beneficial use of manure nutrients and water by vegetation. Both solid and liquid manure should be applied to land using rates and methods that prevent surface runoff of pollutants, as well as the potential for the leaching of pollutants to ground water.

Soil analysis and a manure application plan that balances available manure nutrients with crop needs should be completed before manure application begins. Application rates should not exceed the nitrogen or moisture needs of the plants growing or to be grown on the field site and applied nutrients should be credited in the fertilizer program for the field site. Application of animal manure to cropland at low application rates poses little danger to surface or ground water due to filtering of contaminants by the soil or plant uptake of nutrients.

5. Other management factors

If animal manure storage causes water contamination, IDHW-DEQ can issue a notice which will require corrective measures. All animal waste storage structures should be designed and constructed according to the Idaho Waste Management Guidlines for Confined Feeding Operations. Contact your county planning and zoning office for information about local ordinances, your DEQ regional office about state regulations, and your Farm Service Agency (FSA) or Soil Conservation District (SCD) office about cost-sharing funds.

6. Abandoned manure storage structures

Abandoned manure storage structures, especially earthen ones, can pose significant water quality problems. Any abandoned structure should be completely emptied. In the case of earthen manure storage facilities, liner materials (to a depth of about two feet) should be removed and spread over croplands. The remaining hole should be filled and leveled. Manure packs from structures and lots no longer in use also should be removed and the manure applied to land. If manure is stacked in fields, it should be removed as soon as conditions permit.

Worksheet 7

Animal Manure Storage: Assessing Drinking Water Contamination Risk

1. Use a pencil. You may want to make changes.
2. For each category listed on the left that is appropriate to your homestead, read across to the right and **circle** the statement that **best** describe conditions on your homestead (skip and leave blank any categories that don't apply to your homestead). For categories separated by "**or**," choose only one category.
3. Then look above the description you circled to find your "rank number" (4,3,2, or 1) and enter that number in the blank under "your rank."
4. Complete the section "What do I do with these rankings?"
5. Allow about 15 to 30 minutes to complete the worksheet and summarize your risk rankings for homestead waste disposal practices.

	LOW RISK (rank 4)	LOW-MOD RISK (rank 3)	MOD-HIGH RISK (rank 2)	HIGH RISK (rank 1)	YOUR RANK
LONG-TERM STORAGE (180 days or more) (Addressed in Section 1)					
Manure storage pond (below ground)	Designed and installed according to accepted engineering standards and specifications. Properly maintained. Water table deeper than 20 feet. Built to post-1985 standards.	Designed and installed according to accepted engineering standards and specifications. Properly maintained. Water table deeper than 20 feet. Built to pre-1985 standards.	Not designed to engineering standards. Constructed in medium or fine-textured dense materials (silt loam, loam, clay loams, silty clay). Water table deeper than 20 feet. Earthen lining eroding.	Not designed to engineering standards. Constructed in coarse-textured materials (sands, sandy loam). Fractured bedrock or water table shallower than 20 feet. More than 10 years old. Earthen lining perforated.	_____
or					**or**
Steel, glass-lined (liquid-tight design, above ground)	Designed and installed according to accepted engineering standards and specifications. Properly maintained.	Designed and installed according to accepted engineering standards and specifications. Not maintained.	Leaking tank on medium-textured soils (silt loam, loam).	Leaking tank on coarse-textured soils (sands, sandy loam). Water table or fractured bedrock shallower than 20 feet.	_____
or					**or**
Concrete stave (liquid-tight design)	Designed and installed according to accepted engineering standards and specifications. Properly maintained.	Designed and installed according to accepted engineering standards and specifications. Not maintained.	Concrete cracked, medium-textured soils (silt loam, loam). Water table deeper than 20 feet.	Concrete cracked, coarse-textured soils (sands, sandy loam). Water table or fractured bedrock shallower than 20 feet.	_____
or					**or**
Poured concrete (liquid-tight design)	Designed and installed according to accepted standards and specifications. Properly maintained.	Designed and installed according to accepted engineering standards and specifications. Not maintained.	Concrete cracked, medium-textured soils (silt loam, loam). Water table deeper than 20 feet.	Concrete cracked, coarse-textured soils (sands, sandy loam). Water table or fractured bedrock shallower than 20 feet.	_____

	LOW RISK (rank 4)	LOW-MOD RISK (rank 3)	MOD-HIGH RISK (rank 2)	HIGH RISK (rank 1)	YOUR RANK
SHORT-TERM STORAGE (usually 30-90 days; in some cases, up to 180 days) (Addressed in Section 2)					
Stacked in field (on soil base)	_____	_____	Stacked on high ground. Medium or fine-textured soils (silt loam, loam, clay loams, silty clay). Water table is deeper than 20 feet.	Stacked on high ground or floodplain. Coarse-textured soils (sands, sandy loam). Fractured bedrock or water table shallower than 20 feet.	_____
Stacked in lot	Covered concrete lot with curbs, gutters, and settling basin.	Concrete lot with curbs and gutters. Grass filter strips installed and maintained.	Earthen lot with medium or fine-textured soils (silt loam, loam, clay loams, silty clay). Water table deeper than 20 feet.	Earthen lot with coarse-textured soils (sands, sandy loam). Fractured bedrock or water table shallower than 20 feet.	_____
Water-tight structure	Designed and installed according to engineering standards. All liquids retained.	Designed and installed according to engineering standards on medium and fine-textured soils (silt loam, loam, clay loams, silty clay). Water table deeper than 20 feet.	Designed and installed according to engineering standards on coarse-textured soils (sands, sandy loam). Water table or fractured bedrock shallower than 20 feet.	Designed and installed according to engineering standards. Not properly maintained. Water treatment and diversion and terrace structures allowed to deteriorate.	_____
Stacked in open housing	Building has concrete floor, protected from surface water runoff. Adequate bedding provided.	Building has earthen or concrete floor on medium or fine-textured soils (silt loam, loam, clay loams, silty clay), protected from surface water runoff. Water table deeper than 20 feet.	Building has earthen or concrete floor on medium or fine-textured soils (silt loam, loam, clay loams, silty clay), subject to surface water runoff. Water table or fractured bedrock shallower than 20 feet.	Building has earthen floor on coarse-textured soils (sands, sandy loam), subject to surface water runoff. Water table or fractured bedrock shallower than 20 feet.	_____
NO STORAGE	**(Hauled off farm or spread in less than 30 days)**				
	Hauled off farm for proper storage.	Daily spreading.	_____	***Site not designed for manure storage.***	_____

Boldface type in high risk column: Besides representing a higher-risk choice, this practice also violates Idaho law.

	LOW RISK (rank 4)	LOW-MOD RISK (rank 3)	MOD-HIGH RISK (rank 2)	HIGH RISK (rank 1)	YOUR RANK
LOCATION (Addressed in Section 3)					
Location of animal manure storage in relation to drinking water well	Manure stack or earthen manure storage pit more than 400 feet from well. Manure storage structure (liquid tight) more than 200 feet from well.	Manure stack or earthen manure storage pit more than 250 feet from well. Manure storage structure (liquid tight) more than 100 feet from well.	Manure stack or earthen manure storage pit less than 250 feet down-slope from well. **Liquid-tight manure storage structure less than 50 feet down-slope from well.***	Manure stack or earthen manure storage pit less than 250 feet upslope from well. **Liquid-tight manure storage structure less than 50 feet upslope from well.***	____
MANURE APPLICATION SITE (Addressed in Sections 4 and 5)					
Separation distance and site conditions	Incorporated into unfrozen, unsaturated soil, or applied at site with heavy vegetation more than 200 feet from wellhead.**	Incorporated into unfrozen, unsaturated soil, or applied at site with heavy vegetation less than 200 feet from wellhead.**	Applied to unfrozen, unsaturated soil with no incorporation and little vegetation 200-500 feet from wellhead.	**Applied to frozen, saturated, or snow covered soil. Applied to site with no incorporation and little vegetation less than 50 feet from well-head.**	____
Application rate	Applied at rate of available nutrients equal to or less than plant needs based on soil test.** Annual application less than 250 pounds available nitrogen or less than 20 dry tons of solid waste per acre.	Low rates of application used with no soil tests performed.** Annual application less than 250 pounds available nitrogen or less than 20 dry tons of solid waste per acre.	High rates of application used with no soil tests performed. Rate may exceed plant needs. No farm nutrient management plan.	**Applied at rate greater than plant needs. Annual application more than 250 pounds available nitrogen or more than 20 dry tons of solid waste per acre.**	____

Boldface type in high risk column: Besides representing a higher-risk choice, this practice also violates Idaho law.

*Not allowed by most planning and zoning boards. Existing wells must meet separation requirements in effect at time of construction.

**Applied at the times and rates specified in the farm nutrient management plan.

What do I do with these rankings?

[redacted]

Animal Manure Storage Risk Rankings Summary

CATEGORY	Risk Rank			
	Low 4	3	2	High1
Manure storage pond (below ground)				
Steel, glass-lined (liquid-tight design)				
Concrete stave (liquid-tight design)				
Poured concrete (liquid-tight design)				
Stacked in field (on soil base)				
Stacked in lot				
Water-tight structure				
Stacked in open housing				
No storage				
Location of animal manure in relation to drinking water well				
Separation distance and site conditions				
Application rate				

[redacted]

High Risk Practices (1) Pose a high risk for your health and for contaminating ground water.

Moderate to High Risk Practices (2) Are inadequate protection in many circumstances.

Low to Moderate Risk Practices (3) Provide reasonable ground-water protection.

Low Risk Practices (4) Are ideal; try to make this your goal.

Any shaded rankings require immediate attention. Some concerns you can take care of right away; others could be major or costly projects, requiring planning and prioritizing before you take action. The long term goal of the Home*A*Syst program is to improve homestead practices and structures so that they are classified as low risk. Activities classified as low risk generally reflect best management practices.

Transfer any activities that you ranked in the shaded areas in step 1 to the "High-Risk Activities" on pages two, three, and four of Worksheet B.

[redacted]

Contacts and References

Who to call about...

Manure storage and structure design

• Contact your county Cooperative Extension System (CES), Soil Conservation District (SCD), Natural Resources Conservation Service (NRCS) office, or the DEQ regional office for your area.

Cost-sharing information

• Financial assistance for animal manure management practices, including manure storage, may be available. Contact your local CES or NRCS office.

Animal manure management

• *Agricultural Waste Management Field Handbook*, Soil Conservation Service, 1992. (3) a comprehensive guide addressing animal management and resource protection, contains design standards and accepted animal waste management practices for confined animal feeding operations. Contact the NRCS or the DEQ regional office for your area:

North (Coeur d'Alene):	(208) 769-1422
North Central (Lewiston):	(208) 799-4370
Southwest (Boise):	(208) 373-0550
South Central (Twin Falls):	(208) 736-2190
Southeast (Pocatello):	(208) 236-6160
Eastern (Idaho Falls):	(208) 528-2650

• Contact your County Planning and Zoning Commision for any local regulations pertaining to securing new permits.

What to read about...

Publications are available from sources listed at the end of the reference section. Refer to number in parentheses after each publication.

Ground-water contamination, protection and testing

• *Quality Water for Idaho: Nitrate and Groundwater* CIS 872 (1)
• *Quality Water for Idaho: Water Testing* CIS 873 (1)
• *Quality Water for Idaho: Drinking Water Standards* CIS 874 (1)
• *Quality Water for Idaho: Idaho's Water Resource* CIS 887 (1)
• *Quality Water for Idaho: Groundwater in Idaho* CIS 900 (1)
• *Dairy Waste Management System Planning-Estimating Storage* EXT 694 (1) A list of laboratories certified to conduct water sample analysis is available from your Cooperative Extension System agent or local public health district.

Handling, management, and storage of animal manure

• *Agricultural Waste Management Field Handbook.* NRCS, 1992. (3) A comprehensive guide addressing animal management and resource protection.
• *Livestock Waste Facilities Handbook.* 1985. Midwest Plan Service. (2) Includes information about land application techniques and animal waste utilization, as well as a worksheet to help determine manure application rates.
• *Idaho Waste Management Guidelines for Confined Feeding Operations* DEQ (4)

Planning and design of animal manure storage facilities

• *Agricultural Waste Management Field Handbook.* Soil Conservation Service, 1992. (3) A comprehensive guide addressing animal management and resource protection.
• *Livestock Waste Facilities Handbook.* 1985. Midwest Plan Service. (2) Focuses on planning and design of livestock waste facilities and equipment; includes information about land application techniques and animal waste utilization. Includes a worksheet to help determine manure application rates.
• *Outside Liquid Manure Storages.* 1979. Midwest Plan Service. AED-23. (2) Discusses sizing, emptying, and loading earth storage basins and non-earth above-ground storages.
• *Dairy Waste Management System Planning-Estimating Storage* EXT 694(1)
• *Earth Storage Basins for Liquid Manure* WI/A2795
• *Circular Concrete Manure Tanks.* 1983. Midwest Plan Service. TR-9. (2)
• *DEQ-Idaho Waste Management Guidelines for Confined Feeding Operations* (4)

Land application of animal manure

• *Livestock Waste Facilities Handbook.* 1985. Midwest Plan Service. (2) Includes information about animal waste characteristics, collection and transport to storage, open lot waste handling, land application techniques and waste use. Worksheet helps producers determine manure application rates for their system.
• *How to Calculate Manure Application Rates in the Pacific Northwest* PNW0239 (1)
• *DEQ-Idaho Waste Management Guidelines for Confined Feeding Operations* (4)

Publications available from...

• Your county Cooperative Extension System office. There may be charges for publications, postage, and sales tax.
• Your county Cooperative Extension office or the Midwest Plan Service, Iowa State University, Ames, Iowa, 50011, (515) 294-4337.
• Your local Natural Resource Conservation Service Office.
• Idaho Department of Health and Welfare-Division of Environmental Quality, 1410 N. Hilton, Boise, ID 83706

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Idaho Association of Soil Conservation Districts (IASCD)
Idaho Department of Agriculture (IDA)
Idaho Department of Health and Welfare-Division of Environmental Quality (IDHW-DEQ)
Idaho Department of Water Resource (IDWR)
Idaho Public Health Districts
Idaho Soil Conservation Commission (SCC)
Idaho Water Resources Research Institute (IWRRI)
University of Idaho-Cooperative Extension System (CES)
USDA-Farm Service Agency (FSA)
USDA-Natural Resources Conservation Service (NRCS)
USDA-Rural Economic and Community Development (RECD)
U.S. Environmental Protection Agency (EPA)

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Information derived from **Home*A*Syst** worksheets is intended only to provide general information and recommendations to rural residents regarding their own homestead practices. All results are confidential.